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RED CLOVER

for HAY, SILAGE, PASTURE and SEED

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Experimental Farms Service
CANADA DEPARTMENT OF AGRICULTURE
Ottawa, Ontario

COVER PICTURE

A typical head of red clover in full bloom, showing color and arrangement of the individual florets, leaves and leaf markings. Flowers are borne in compact heads at the ends of branches as illustrated.

Red clover is almost completely self-sterile and each individual floret in each head must be cross-pollinated with pollen from another plant in order to set seed. Pollination is accomplished entirely by insects, chiefly bees. Since each flowering head consists of from 100 to 125 individual florets, it can be readily seen that large numbers of pollinating insects are necessary in order to obtain high seed yields.

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RED CLOVER

For Hay, Silage, Pasture and Seed

by

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INTRODUCTION

Red clover is one of the most important and most widely grown of all cultivated legume crops. As a companion species with grasses and other legumes in short-term rotations, red clover has an important place in Canada. No other legume meets the varied soil conditions or different crop uses so well as red clover. While no data are available on the exact acreage devoted to red clover, a fair estimate would be that about 5 million acres of land under cultivation are sown to red clover or to hay or pasture mixtures containing this species.

Red clover has many qualities which rate it an important forage crop. Being a legume crop it has the faculty of storing nitrogen obtained from the atmosphere in the nodules on its roots and is useful, therefore, in improving the fertility of the soil. Red clover gives large yields of high-quality forage which may be used for hay, silage or pasture.

Problems concerning the culture of red clover for the production of hay, silage, pasture and seed are discussed in this bulletin. The information is based mainly upon the results of investigations conducted by the Experimental Farms Service over a period of years.

SOIL AND CLIMATIC ADAPTATION

Red clover is widely adapted to most agricultural areas in Eastern Canada. In Western Canada, it is adapted to the agricultural areas of British Columbia, to most of the black and grey wooded soil zones of Alberta and Saskatchewan, and to the slopes of the Swan River Valley and the inter-lake area of Manitoba. Red clover is not recommended for use on the non-irrigated areas of the brown and dark brown soil zones of the Prairie Provinces, nor on the drier areas of the black soil zone, such as are found in large districts of southeastern Saskatchewan and western Manitoba. In these latter areas alfalfa is generally more productive.

Red clover is fairly winter-hardy and grows best in clay or clay loam soils containing abundance of lime. It is not adapted to strongly acid, poorly drained or very light sandy soils. However, it is somewhat more tolerant of acid soils than is alfalfa or sweet clover. It is well suited to fairly humid regions with moderate temperatures. Red clover does not thrive under prolonged periods of drought. It may be winter-killed, heaved or uprooted by alternate thawing and freezing, particularly in the early spring. Although not so well adapted as alsike clover to low, poorly drained soils, red clover is less exacting in this regard than alfalfa.

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DESCRIPTION OF TYPES

Red clover (*Trifolium pratense* L.) belongs to the pea family, Leguminosae. Taxonomically red clover is regarded as a biennial but agriculturally, life tenure cannot be strictly defined, as plants may live two or more years depending on variety, type, soil and crop management. Individual plants vary widely with respect to number of flowering shoots, hairiness of leaves and stems, colour of flowers, and leaf shape and markings. Plants are composed of numerous, branching, leafy stems which arise from the crown and which normally reach a height of from one to three feet at the stage of full bloom. Flowers are borne in compact heads at the ends of branches, each head containing numerous white, pink, red or reddish-purple flowers. Leaves of the plant are made up of three oblong-shaped leaflets on a slender stalk. Leaflets usually have light-coloured markings in the centre. The root system consists of a number of primary roots with numerous fibrous roots extending from these and from the base of the crown.

There are two main types of red clover grown in Canada. These are distinguished by their habit of growth:—(1) Late-flowering or *single-cut* red clover which produces only one crop of hay or a crop of seed in a season and (2) early-flowering or *double-cut* red clover, which produces two hay crops or one hay crop and a seed crop in one season.

Figure. 1—Comparison of double-cut and single-cut red clover in the year of establishment. The double-cut variety (upper) develops some flowering stems while the single-cut (lower) forms a leafy rosette without any indication of stems.

Single-cut types are relatively slow-growing. They produce no flowering stems the first year but each plant forms a large leafy rosette. In the second year they begin growth rather slowly. They usually come into flower about 10 to 14 days later than double-cut types. In all single-cut varieties very little aftermath is produced unless they are cut early. Generally they are longer-lived than double-cut varieties and under favourable conditions stands of some varieties may persist for four or more years.

Double-cut types are relatively fast growing. Most plants produce flowering stems the first year with only a few having a weak rosette formation. In the second year double-cut types make a rapid growth and produce flowering stems which bloom early. Recovery is rapid after the first cutting making it possible to obtain a second crop of either hay, pasture or seed. Usually only a relatively small percentage of plants of double-cut strains live more than two years.

Double-cut types of red clover are most popular in the main clover areas of Canada, namely southwestern Quebec, Ontario, the Maritime Provinces and the inter-mountain areas of central and southern British Columbia. This is

mainly because the growing season is sufficiently long to permit a good aftermath for use as hay, seed or pasture. Single-cut types, on the other hand, are better adapted to northern clover growing areas where a short growing season makes it difficult to harvest more than one crop of hay per season. In tests at experimental stations in northern Ontario and Quebec, Altaswede, a single-cut variety has proved superior in yield and hardiness to all double-cut varieties tested. Single-cut types are grown in Alberta, Manitoba and in parts of northern Ontario and northern Quebec.

DESCRIPTION OF VARIETIES

The main double-cut varieties grown in Canada are Ottawa, Dollard, Lasalle and Redon, while single-cut varieties grown are Altaswede, Manhardy, Mammoth, Leon and Siberian.

Ottawa—a double-cut variety which originated at the Central Experimental Farm, Ottawa. It is widely grown in the main clover-growing areas of Ontario and Quebec. In tests with other varieties throughout the country it has proved to be high-yielding and winter-hardy. Because of its hairy stems and leaves, it is highly resistant to attacks by the potato leafhopper. It possesses some degree of resistance to common diseases including powdery mildew and sclerotinia root-rot.

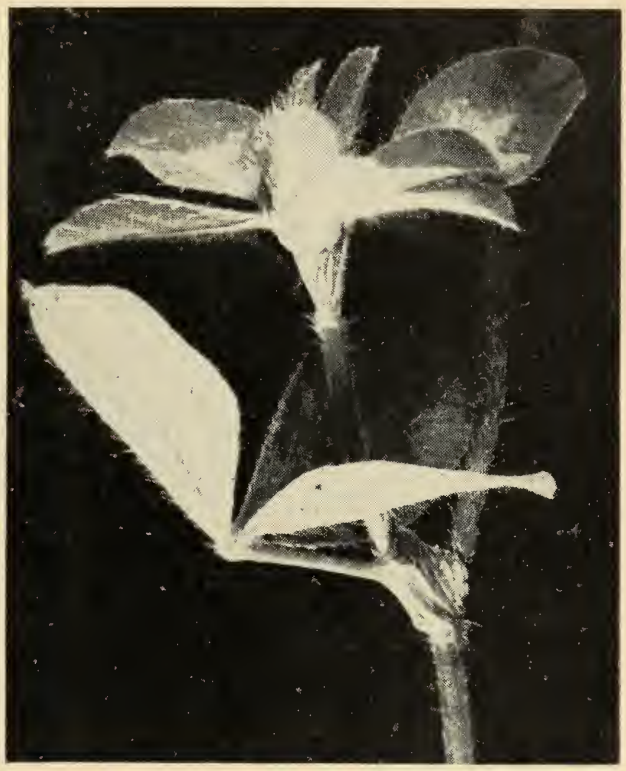

Figure 2.—Red clover plants vary in the degree of leaf and stem hairiness. They may be strongly haired as shown, or they may be sparingly haired or smooth. Most Canadian double-cut varieties are hairy and because of this have a degree of resistance to leaf hopper damage.

Dollard—a double-cut variety which originated at Macdonald College, Ste. Anne de Bellevue, Quebec. It is slightly later in maturity than Ottawa and contains a greater range of types. In tests with other varieties it has proved to be winter-hardy and a very good yielder of leafy hay and aftermath. While it has not been selected for disease resistance, the conditions under which it was selected have given it some resistance to powdery mildew, northern anthracnose and sclerotinia root-rot diseases. It is well adapted to the clover growing areas of Eastern Canada.

Lasalle—a new variety produced by blending seed of the Dollard and Ottawa varieties at the foundation stock level. Dollard and Ottawa, on the average of extensive yield tests, have proved to be equally desirable for yield, type and winter-hardiness. Each possessed some resistance to different diseases but there seemed to be no logical choice between the two. Consequently it was decided by the committee administering the Canadian Forage Seed project to make a composite of these two and call the variety Lasalle. The original varieties will continue to be improved and foundation seed for the blend produced by the institutions concerned. However, the new variety will gradually replace the two parent varieties on the market.

Redon—a double-cut variety produced by the Ontario Agricultural College, Guelph, Ontario. According to the licence description it is a composite strain of selections from several introductions. It is characterized by leafiness and a degree of disease resistance, especially to sclerotinia, mildew, and mosaic. Being a comparatively new variety (1944) it has not been thoroughly tested in all parts of the country.

Altaswede—a single-cut variety, developed at the University of Alberta by artificial and natural selection over a period of years from Late Swedish red clover. In tests conducted on a number of Experimental Farms in recent years it has proved to be one of the better yielders of hay. Stems of most plants are free from hairs or have appressed hairiness and for this reason the variety does not possess much resistance to leafhopper.

Manhardy—a single-cut variety developed by the Manitoba Agricultural College. It is similar to Altaswede in type but in variety tests on Experimental Farms in Canada it has not yielded quite so well as Altaswede on the average. It has been outstanding, however, in winter-hardiness.

Leon—a single-cut variety produced by the Ontario Agricultural College. According to licence description it is a composite strain of selections from introductions. Selection has increased longevity as well as leafiness and disease resistance. It was licensed at the same time as Redon and has not been widely tested.

Siberian—a single-cut variety which came originally from Siberia. It has a semi-prostrate habit of growth, flowers profusely but is somewhat lacking in leafiness. It is a very early variety coming into flower earlier than most of the double-cut varieties. It has proved to be very winter-hardy having shown 80 per cent survival at Ottawa in a winter when Ottawa and Dollard were completely killed and Manhardy survived 50 per cent.

Mammoth—a single-cut type but is distinct from Manhardy and Altaswede in that it is more hairy and somewhat coarser and growthier. It is grown for seed in parts of northern Ontario notably in the Oxdrift district although this northern grown seed is more or less mixed with the early two-cut type. In yield tests of red clover varieties for hay, conducted at various Experimental Farms across Canada, Mammoth has not yielded so well on the average as Altaswede or Manhardy.

DISEASES AND HARMFUL INSECTS

Numerous diseases and insects attack red clover. Some may cause severe injury or kill the plants; others, by their injury to leaves or stems, may reduce hay yields or quality of hay. A few may attack at periods of the year when they have no effect on yield or quality of hay. The most important and most common diseases and insects found on red clover in Canada will be described briefly.

Sclerotinia Root-Rot or Crown Rot—*Sclerotinia trifoliorum* Eriks. This disease is widely distributed in the clover-growing areas. If present in a field it may cause a considerable reduction in stand in seasons which are favourable for its development. Killing usually takes place in the spring of the second year of growth. First symptoms of the disease may occur in the fall, but these would probably go unnoticed to the casual observer. Leaves have brown spots in late fall and drop off if they become heavily infected. The spring symptoms are more evident. There is a soft rot of the crown and roots. New growth

of infected plants may wilt and die. Dead or badly infected plants pull easily and one or more irregular-shaped black bodies called sclerotia are found at the base of the stem or around the crown. These vary in size from 1/10 inch to 1/2 inch or more in diameter. No varieties of red clover are completely resistant to the disease, but Canadian varieties usually are less susceptible than imported strains. A good system of crop rotation helps to control the disease.

Powdery Mildew, *Erysiphe polygoni* D.C., is commonly found on red clover, wherever it is grown. Heavy epidemics may cause some reduction in quality and yield of hay. However, infection is not usually heavy until late in the season and therefore has little effect on the hay crop. The disease appears as a light grey powdery growth on the surface of the leaves. Leaves may turn yellow and die. Spread of the disease is rapid under favourable conditions in late summer and early fall. Control of the disease is by use of resistant varieties. Most Canadian varieties have some resistance to the disease.

Northern Anthracnose, *Kabatiella caulivora* (Kirch.) Karak—This disease occurs in different parts of Canada but has never been severe in the main clover-growing areas. It may be recognized by dark brown injuries on the leaves, leaf stems and main stems. The brown lesions develop as sunken linear areas on the main stems and leaf stems. The infected areas may increase in size and cause a girdling of stems resulting in killing and browning of leaves.

Rust, *Uromyces trifolia* (Hedw. f.) Lev., is common on clover in all the main clover-growing areas of Canada. Usually damage is not severe as the attack does not become heavy until late fall. Small light yellow to brown pustules are found on leaves and stems.

Mosaic—There are a number of mosaic diseases of red clover caused by viruses. Some of the symptoms are a mottling of the leaves, dwarfing, or a yellowing along the veins of the leaves. There are no means of controlling the disease at present.

Figure 3.—Comparison of normal red clover plant (upper) and plant attacked by virus disease (lower). Virus or mosaic disease, which occurs in several forms, frequently attacks red clover. The form illustrated here causes a dwarfing of the plant which fails to produce normal bloom. The leaves are small, crinkled and discoloured at the margins. Picture taken July 26, 1951 when normal plants were in second bloom.

Clover Root Borer, *Hylastinus obscurus* Marsham, is present in almost all areas where red clover is grown. It is one of the most destructive enemies of the crop and in some areas is one of the principal causes of reduced clover stand after the first year of crop. The borer feeds on the clover roots. Eggs are laid in the burrows of the root in early summer. Young borers develop and remain in the root in both immature and adult stages until the following

spring. In the spring the beetles migrate from old clover to new clover fields where they lay their eggs. Damage to red clover by the root borer is usually observed after the first crop of hay is taken. Plants are killed or reduced in vigour and fail to make a good second growth. A badly infected field should be plowed after the first crop of hay is removed. If the clover roots are harrowed to the surface, the young borers will be killed when the roots dry out.

Potato Leafhopper, *Empoasca fabae* Harris, is a small, light-green-coloured hopping insect which is a serious pest on red clover in areas where infestations are common. Both adult and young insects puncture the stems or leaves of the plant and suck juices causing the leaves to turn red or yellow. Some of the Canadian double-cut strains, because of their hairy stems, are able to resist attack by the insect.

Insects which adversely affect the seed yield will be described under the section on seed production.

RED CLOVER IN CROP ROTATIONS

Since red clover does not usually behave as a perennial, it is particularly adapted to short rotations. For instance, red clover may be seeded with a grain crop to provide a soil-improving legume sod crop to precede a cash crop such as potatoes in the rotation.

Sod crops play an important role in the maintenance of soil fertility. The root residues from such crops are considerable and provide material for replenishing the soil organic matter, an important property of soils. Since red clover is a legume and obtains much of the nitrogen required for growth from the air, it is particularly valuable in this respect. In a sequence-of-crops experiment conducted on a loam soil by the Field Husbandry Division, Central Experimental Farm, Ottawa, red clover was compared with other crops with respect to its effect on the yield of such succeeding crops as oats, corn, mangels and potatoes, grown in a 3-year rotation with oats as the third-year crop. The data in Table 1 indicate that red clover was one of the best preceding crops as measured by the yield of the crop that followed in the rotation. There was little difference in the yield of oats, corn, and mangels whether these crops followed red clover or alfalfa. Although the yield of potatoes following red clover was somewhat less than that following alfalfa or timothy, the yield was much higher than that obtained for potatoes grown after such crops as oats, corn and potatoes. The results illustrate the value of a legume sod crop in the rotation. Not only does such a crop provide feed relatively high in protein, but there are beneficial effects on other crops in the rotation.

Table 1.—Yields of different succeeding crops grown after red clover and other preceding crops at Ottawa, Ontario, 1935-44

Preceding Crop	Average Yield per Acre of Succeeding Crop*			
	Oats	Corn	Mangels	Potatoes
	bu.	tons	tons	bu.
Red Clover	58·0	17·3	27·9	215·0
Alfalfa	60·2	17·0	28·9	224·2
Timothy	48·4	15·4	25·7	224·3
Oats	49·0	14·2	23·0	176·2
Corn	54·7	14·1	25·1	179·3
Potatoes	53·3	13·5	25·6	148·2

* 10-year averages for corn and oats; 9-year averages for mangels and potatoes.

Where livestock raising is the main enterprise, red clover is not so satisfactory as alfalfa which is a perennial legume. However, where soil and climatic conditions are unfavourable for alfalfa as in many sections of Eastern Canada, the seeding of red clover in a mixture with grasses is a practice to be recommended.

ESTABLISHMENT OF STANDS

While red clover establishes as readily, if not more so, than the other commonly grown legumes, certain considerations must be kept in mind if a good stand is to be ensured.

Choice of seed

The choice of seed is of primary importance in the growing of productive crops of red clover. Too much emphasis cannot be placed on the necessity of using pure seed of high germination and whenever possible, seed of named, adapted varieties of Canadian origin. Tests have revealed that the highly adapted Canadian varieties are more hardy and more productive under our conditions than red clover from foreign sources. By obtaining registered or certified seed the grower can be certain that he will be using seed guaranteed as to trueness of variety, high germination and comparatively low weed-seed content.

The National Forage Seed Project initiated in 1952 has as its objective the increased production of pedigree seed of recommended varieties. Thus within a relatively short time registered and certified seed of the most desirable varieties should be available in considerable volume in the seed trade.

Figure 4.—Proper plowing and cultivation practices which provide a relatively firm seed-bed are important considerations in establishing good stands of red clover.

Choice of land

Soils with ample moisture but with moderate to good drainage are best for red clover. The crop will not withstand extreme drought, but on the other hand, under poor drainage conditions, winter-killing is likely to be severe. Neutral soils or those slightly acid are favourable for red clover. On more acid soils (pH value below 6·0) and on soils where drainage is less favourable, alsike is better adapted than red clover.

Preparation of Soil

Red clover is established and grows favourably when seeded following a hoed crop. However, it may be seeded following a grain crop. Hoed crops or a grain crop following an old sod will provide an opportunity for decomposition of the sod before establishment of red clover. The land should be thoroughly cultivated or ploughed in the fall after the hoed crop or grain is harvested. In the spring, cultivation should be commenced early in the season in order to prepare a fairly fine but relatively firm seed-bed. The importance of a firm seed-bed will be discussed later in relation to methods of seeding. If an attempt is made to establish red clover following sod, the land should be ploughed in early August, and cultivated at frequent intervals for the remainder of the season in order to break up the sod and eradicate weeds. If no manure is applied it may not be necessary to replough in the fall.

Fertility Treatments

To produce a good crop of red clover relatively large amounts of phosphoric acid, potash and lime are required. However, being a legume it obtains nitrogen from the air, so that usually it is not so necessary to provide this constituent in the form of commercial fertilizer. In fact, even though the crop is harvested, the large quantity of root residues aids in maintaining the organic matter and nitrogen content of the soil. Thus, for red clover, emphasis must be placed on a liberal supply of phosphoric acid, potash and lime where needed. Although red clover will tolerate slight soil acidity, many soils in Eastern Canada and British Columbia require liming before a satisfactory yield of this crop can be obtained. However, neutral and alkaline soils do not require lime. Simple tests are available to determine whether or not lime is needed. For the same intensity of acidity, clays will require more lime than sandy soils in order to correct this condition. The liming material may be applied in spring or fall according to convenience. It is advisable to apply the lime previous to seeding red clover so that the material may be worked into and mixed with the soil when preparing the seed-bed.

Many experiments in humid regions have shown the beneficial effects, on the yield of red clover, of manure applied for a hoed crop preceding the clover crop. When seeding down with a nurse crop of wheat, barley or oats, it is desirable to use a fertilizer which will benefit both the nurse crop and the red clover. Although the nurse crop might benefit from relatively higher levels of nitrogen in the fertilizer, it is advisable to restrict the supply of nitrogen somewhat, when seeding a legume such as red clover. Otherwise, a relatively rank grain crop may result in a poor stand of red clover.

In Eastern Canada and British Columbia, fertilizer analyses such as 3-18-9 on soils of heavier texture and 2-12-10 on the lighter soils should prove satisfactory in most instances. The rate of application should vary from 200 to 500 pounds per acre according to previous manurial treatments and the fertility of the soil. For a more concentrated fertilizer such as 4-24-12, the rate would be reduced proportionately. Where the soil is relatively fertile and contains sufficient nitrogen for the nurse crop as may occur on land heavily manured, a fertilizer such as 0-16-8 or 0-12-12 for medium textured soils and superphosphate only for clays and clay loams, may be recommended when seeding red clover.

The soils of the grey wooded zone in the Prairie Provinces tend to be deficient in organic matter, nitrogen, phosphorus and sulphur. Legumes in the rotation in this area are particularly desirable, and applications of manure are beneficial. Legume crops on these soils are improved in many instances by fertilizers containing sulphur. Ammonium sulphate or 16-20-0 containing sulphur are suitable fertilizers and may be applied at about 50 pounds per acre.

Inoculation

Since red clover is a legume it is able to utilize the free nitrogen in the air by the aid of certain bacteria which live and multiply in nodules on the plant roots. Without these bacteria, red clover will not thrive and produce maximum yields. Different species of leguminous crops usually require a specific kind of bacteria. However red clover, alsike and wild white clover are able to benefit from the same kind of bacteria. On fields where these crops have been grown successfully, these desirable bacteria will be present. To ensure their presence in soils where red clover has not been grown, they should be introduced artificially by inoculation. In order to establish the most efficient nitrogen-fixing strains, it is advisable to use artificial cultures occasionally even where red clover has been grown previously.

There are two general methods of inoculation. One method is to broadcast 200 to 500 pounds of the surface soil from an old red clover field, on the area to be seeded to red clover. A more convenient and more effective method is to treat the seed just before sowing, with a specially prepared culture of the proper bacteria. The cultures, sometimes called "nitro cultures", are distributed by a number of Agricultural Colleges, seed houses or other commercial firms at a small cost and instructions for applying are supplied with the culture.

Time and method of Seeding

Except when grown specifically for seed, red clover is usually seeded in a mixture with other legumes and grasses along with a nurse crop of oats, barley or wheat. The advantage of a nurse crop is that it competes with weeds, and a crop of grain is obtained in the year of establishing of the red clover. It is often advantageous to reduce the usual rate of seeding the nurse crop when seeding down to red clover. Otherwise, the competition by the grain crop for moisture and light, among other factors, may result in an inferior stand of the new seeding of legumes. Red clover should be seeded with the nurse crop as soon as the soil is in good condition for cultivation in the spring. In the Prairie Provinces, red clover may be seeded in some instances without a nurse crop, but this is not so satisfactory on weedy land. However, where moisture conditions are more favourable, the land may be cultivated for weed control prior to seeding as late as the early part of July. Fall seeding of red clover is not successful in Canada.

With the exception of areas where moisture is limited as in the Prairie Provinces, red clover should not be seeded deeper than one-half inch. In an experiment conducted by the Field Husbandry Division, Central Experimental Farm, the average yield of red clover hay per acre for a 3-year period was 1·81 tons where the seed was applied on the surface and raked in, 1·45 tons for seeding at a depth of one-half inch, 1·33 tons for a depth of one inch and 0·89 tons for a depth of 2 inches.

Seeding of red clover with a grass-seed attachment on an ordinary grain drill, designed to deliver the seed behind the disks or shoes of the drill, is the usual method employed. The previously cultivated land should be rolled before seeding, and the seed may be covered by harrowing with a light harrow or preferably pressed into the soil with a roller or packer. A culti-packer with

seeder attachment provides for shallow seeding in a firm seed-bed. The seeds drop between the two corrugated rollers and are pressed into the soil. In an experiment conducted for a 10-year period at Ottawa, where red clover was seeded broadcast and in drills, the average yield of hay per acre was 1·66 tons for broadcast seeding, 1·92 tons for seeding in drills spaced at 3·5 inches and 1·84 tons for drills spaced at 7 inches. These results tend to support seeding in drills more closely spaced than the 7-inch depressions, made by the disks of the grain drill, where the grass seed tends to accumulate when seeded with the grass-seed attachment.

Rates of Seeding Red Clover for Hay, Pasture or Silage

Data secured from an experiment conducted by the Forage Plants Division, Central Experimental Farm, showed considerable variation in the yields of hay or pasture when sown at different rates.

It may be seen in the upper half of Table 2 that the highest yield of hay was secured from 3 pounds of red clover and 12 pounds of timothy. The yield of pasture was the highest when the seeding rate was 6 pounds of red clover and 9 pounds of timothy.

Data in the lower half of Table 2 are on mixtures sown in the same proportion of 60 per cent timothy to 40 per cent clover, but the total amount of seed per acre was varied from 10 to 25 pounds. The highest yield of hay was obtained when this mixture was sown at the rate of 15 pounds per acre. This rate was considerably better than the lower rate in this test. The yield of pasture was equally good when sown at 15 and at 25 pounds per acre. Thus these data indicate that the amount of red clover seed required is about 6 pounds per acre, but a higher rate of seeding is usually a valuable insurance for better and more uniform stands.

The most common rates of seeding red clover in mixtures in Eastern Canada are from 6 to 8 pounds of red clover, 8 to 10 pounds of timothy and usually one or two pounds of alsike per acre.

Table 2.—Rates of Seeding Red Clover and Timothy for Hay and Pasture at Ottawa, Ontario

Rate of seeding in pounds per acre	Total rate of seeding per acre	Dry matter yield per acre	
		Hay 2 cuts	Pasture 4 clippings
	lb.	lb.	lb.
Timothy, 12, Red Clover 3	15	7,957	7,759
" 9, " " 6	15	7,737	7,883
" 6, " " 9	15	7,767	7,663
" 3, " " 12	15	7,611	7,434
" 6, " " 4	10	7,086	7,566
" 9, " " 6	15	7,764	7,829
" 12, " " 8	20	7,631	7,540
" 15, " " 10	25	7,443	7,899

In areas where alfalfa is not well adapted, the following mixture is recommended for short-term hay-pasture purposes; red clover 8, timothy 8, alsike 2 and ladino or white dutch clover 1. However, if alfalfa can be grown successfully a mixture suitable for the same purpose may consist of the following: red clover 6, timothy 6, alfalfa 6, alsike 1 and ladino 1 (rates in pounds per acre).

Red clover may be used in many other mixtures which are intended for hay, pasture or silage. The amount of red clover seed required per acre usually

varies with the kind and amount of other species present in the mixture for different purposes and for different soil and climatic conditions. However, if red clover is intended for seed, it may be sown alone at 8 to 10 pounds per acre. It may be sown also in simple mixtures with one or more grasses or combined with such legumes that will not interfere with the growth of the crop or the harvesting of red clover seed.

Management of Crop The First Season

In recent years it has been found possible to kill wild mustard, stinkweed, lamb's quarters and other species of annual weeds that occur in grain crops, by use of the herbicide 2, 4-D. Although red clover is less susceptible to injury by this chemical than are alfalfa or sweet clover, nevertheless, care must be exercised in the use of 2,4-D for the control of weeds in a grain crop seeded to legumes including red clover. If the seeding contains alfalfa or sweet clover, this herbicide should not be used, as severe injury to these legumes will result. Red clover will tolerate up to 4 ounces of the pure acid per acre. This is best applied when the weeds are in the seedling stage and the grain crop is about 6 inches high. However, uniformity of application of this relatively low rate is essential. Otherwise, parts of the field will receive more than the tolerated amount of herbicide and injury to the red clover stand will occur. For further information regarding 2,4-D, reference may be made to "Simplifying 2, 4-D", Publication No. 807, Canada Dept. of Agriculture, Ottawa.

Usually the nurse crop is harvested at maturity so that the yield of grain is obtained. In some instances, particularly where moisture is limited, it may be advantageous to remove the nurse crop at an earlier date by pasturing or by curing it for hay. This enables the clover to make good growth in the year of seeding and to store up reserves in the roots so that the crop goes into winter in an ideal condition with more resistance to disease and winter-killing.

Top dressing of the new seeding in the fall with barnyard manure is to be recommended. Where manure is not available, an application of 200 to 300 pounds of 0-16-8 or other suitable fertilizer will be beneficial for red clover on soils deficient in phosphorus and potash. This may be applied in the fall of the year of seeding or in the following spring.

Red clover may be pastured lightly during the year of seeding. Grazing heavily or cutting the crop for hay or silage the year of seeding, followed by new growth in the fall, results in depletion of the root reserves, so that the crop goes into the winter in a weakened condition. This is likely to result in a thin stand. Therefore, under most conditions it is best not to use red clover in the year of establishment.

USES OF THE CROP

Hay

On many farms red clover is the standard legume cut for hay. If cured so that most of the leaves are retained, good quality red clover hay contains approximately twice as much protein as timothy hay. It is readily eaten by all classes of livestock.

Silage

Red clover is used extensively as a silage crop in some parts of Canada. When grown alone or in mixtures this crop can be made into excellent silage if cut when the clover is in the mid-bloom to full-bloom stage. Red clover, when

ensiled, contains more carotene, which is the source of vitamin A, than when cut for hay.

Pasture

Red clover provides good pasture for all kinds of livestock. However, like alfalfa, it may cause bloat and certain precautions must be taken. A mixture of red clover and grasses is less likely to cause bloat than pure stands of clover. After one crop of hay or ensilage is taken off the aftermath may be used for pasture. A limited amount of grazing may be obtained also after a crop of seed is taken off.

Seed

Seed production of the double-cut type of red clover in Canada is more or less incidental to its production for hay. The majority of farmers grow red clover primarily for forage, and they utilize the second crop for seed purposes only when it appears profitable to do so. It is not a general practice to grow red clover for its seed alone, except in the case of late or single-cut types.

Combination of Uses

Red clover alone or in mixtures with grasses is often used in more than one of the ways already mentioned. An early crop of hay or silage may be taken off and the aftermath may be used for second-cut hay, pasture or left for seed. This can be done with the early or double-cut types of red clover. The late or single-cut varieties cannot be used in as many ways. When a crop of hay or ensilage is taken the aftermath will give a light second crop of hay or it may be grazed off, but it will not produce a crop of seed that year.

RED CLOVER AS HAY

Effect Of Stage Of Maturity On Quality Of Hay

Most of the red clover hay in Canada is made from the first cutting of the crop following the year of establishment. To obtain a good yield of the best quality hay, red clover should be cut not later than the full bloom stage and before any heads have turned brown. At this stage the maximum yields of dry matter and protein may be obtained and the plants are still green and contain a high proportion of leaves. Clover at this stage contains a high percentage of protein, calcium and phosphorus and has a low percentage of crude fibre.

Table 3, shows the average yields obtained and the chemical composition of first- and second-cut hay of double-cut red clover harvested at different stages of maturity. These data show also that it is desirable to cut the first crop early so that the yield of hay from the second crop may be increased. For best results the second crop should be cut for hay at the full-bloom stage. The hay will be of much higher quality at this stage than when the crop is allowed to become more mature.

Mixed grass and red clover hay should be cut at the stage of maturity recommended for pure clover, irrespective of the stage of maturity of the grasses in the mixture.

Methods Of Curing And Harvesting

The various methods that may be used in the curing and harvesting of red clover should aim at removing the crop from the field and storing it in the barn with the least amount of handling possible. Leaf loss should be kept to a minimum since the leaves contain the larger part of the protein of the crop.

Table 3.—Yield and Composition of Red Clover Cut at Different Stages of Maturity. Double-cut Variety Grown at Ottawa, Ontario

Date of Cutting		Stage of maturity at harvest	Yield per acre		Chemical composition calculated to water-free basis			
			Dry Matter	Protein	Protein	Crude fibre	Calcium	Phosphorus
			lb.	lb.	%	%	%	%
June 7	1st	Bud stage	2,932	523·4	17·85	24·15	1·41	0·32
Aug. 4	2nd	25% heads brown	838	150·0	17·90	33·43	1·43	0·19
	seasonal	total	3,770	673·4				
June 16	1st	50% blossom	3,580	607·5	16·97	25·52	1·52	0·30
Aug. 4	2nd	75% "	999	183·4	18·36	31·84	1·46	0·20
	seasonal	total	4,579	790·9				
June 22	1st	80% blossom	3,485	535·6	15·37	28·31	1·40	0·29
Aug. 4	2nd	60% "	780	148·4	19·03	32·30	1·45	0·24
	seasonal	total	4,265	684·0				
June 29	1st	25% heads brown	3,446	471·1	13·67	26·09	1·36	0·25
Aug. 4	2nd	50% blossom	749	146·3	19·53	23·32	1·42	0·23
	seasonal	total	4,195	617·4				
July 6	1st	80% heads brown	3,292	440·1	13·49	27·45	1·43	0·22
Aug. 4	2nd	15% blossom	738	138·8	18·81	23·54	1·46	0·23
	seasonal	total	4,030	578·9				
July 13	1st	100% heads brown	3,107	392·3	12·63	30·13	1·43	0·20
Aug. 4	2nd	bud stage	606	113·3	18·69	24·92	1·44	0·23
	seasonal	total	3,713	505·6				

Figure 5.—Tractor type power-take-off side-delivery rakes can be used effectively in harvesting red clover hay.

Red clover should be allowed to wilt for four or five hours in the swath following mowing. The crop may then be raked into windrows, two swaths to a windrow, with a side-delivery rake. This implement is most suitable for this purpose because the hay is rolled in such a manner that the stems of the crop are left on the outside while the leaves remain in the centre portion of the windrow. The required period of curing in the windrow will depend on the weather conditions. Under favourable drying conditions the crop will probably be dry enough for storage in one to two days. During that time it may be necessary to turn the windrow over to allow the wind and sun to dry the underside, particularly if the crop has been wetted by rain.

The hay should contain not more than 22 per cent moisture at time of storage. This level of moisture is determined largely by experience in handling the crop. Hay usually has a characteristic rustle or "rattle" when dry enough to store. The stems should be dry and crisp, and break when twisted by hand. Hay that twists into a "rope" or exudes moisture under such a test is too wet to store. In areas of humid weather conditions, the curing and harvesting of the crop becomes more difficult and methods may have to be modified to meet this problem.

Methods used in moving the crop from the windrow into storage vary with the conditions which exist on each individual farm. The efficiency and cost of handling the crop will depend on the value of the equipment involved and the volume of hay harvested.

Hand Loading Method—Following partial drying in the windrow, the hay may be coiled into medium-sized cocks or coils of 80 to 100 pounds of hay. After two to three days further drying in the coils, the crop may then be hand loaded on a wagon or truck and hauled to storage. This method of gathering hay is used on many farms where relatively small acreages are harvested or where the fields are irregular in size, stony, or rough.

Hay Loader Method—This is the most common method of harvesting hay and involves a modest investment in equipment. The time and labour required to load are considerably reduced as compared with the hand loading method.

Buck Rake Or Sweep Rake Method—A buck rake or sweep rake may be used for gathering the hay crop from the windrow and transporting it to the barn. Such equipment however is only practical where relatively short hauls are required and relatively small tonnages harvested. In addition, the fields must be smooth and firm. The sweep rake may be mounted on a tractor or an old automobile chassis.

The Baler Method.—The field baler picks up the hay from the windrow and presses the hay into small bales or bundles, thus facilitating removal from the field. While this method reduces the amount of labour involved in harvesting, this may be offset by the financial outlay for this piece of equipment. Such equipment is particularly useful where the crop must be shipped a considerable distance, or where the storage space is limited. In baling hay, the crop must be as dry or drier than loose hay for storage. Various types of balers are available, making either round or rectangular bales and using wire or twine in their operations.

Forage Crop Harvester Method—The use of the forage crop harvester in haying operations reduces the manual labour to a minimum but requires a considerable investment in equipment. The hay is cut, windrowed, and cured in the regular manner. The harvester picks up the crop from the windrow and chops the hay into at least four-inch lengths and deposits it into a wagon. The moisture content of the crop must be as low as that of hay stored by other means, and the chopped hay should not be tramped when stored lest heating occur.

Barn Curing Hay—In this method of handling the crop, the hay is partially cured in the field and then placed in a hay drying unit to complete the drying process. For such a method, a mow with a slatted floor is required, complete with a motor and fan to force hot or cold air through the mow. Such a method has been developed to speed up the field drying period and reduce the leaf loss in harvesting.

Where such a method is used several factors must be considered. Hay should not be placed in the mow until it is two-thirds cured or contains less than 40 per cent moisture. The crop must be spread evenly and tramping kept to a minimum.

The various types of hay harvesting equipment and their efficiency are more fully discussed in "Harvesting Machinery for Hay and Silage Production", Publication 885, Canada Department of Agriculture, Ottawa.

RED CLOVER FOR SILAGE

Red clover is one of the most important forage crops used for silage purposes. However, like alfalfa and other leguminous crops, more care is required in preparing the crop for ensilage than is necessary with the grasses or mixed-hay crops.

Red clover contains a relatively low percentage of carbohydrates (starches, sugars, etc.) and a high percentage of protein. For the successful production of silage a lactic acid type of fermentation is desired and this can only take place if the crop contains sufficient carbohydrates for the bacteria to promote this fermentation fairly rapidly. If such conditions are not provided, other races of bacteria develop and attack the protein of the crop producing a butyric acid type of fermentation (sour silage) which may render the material unfit for feed.

Figure 6.—Red clover silage can be harvested efficiently in the field with the silage sweep rake where the length of haul is less than 1/3 of a mile. This unit carrying 500 to 600 pounds per load will handle approximately 1½ to 2 tons per hour.

Importance of Moisture Content

The moisture content of the crop at time of ensiling is an important factor determining the success of the silage process. Experiments at Ottawa have shown that excellent silage can be produced when the crop contains 65 per cent to 75 per cent moisture. If the chopped material when squeezed in the palm of the hand does not ooze moisture but slowly springs apart on opening of the hand, the moisture content will be in the desired range. The crop should be harvested from the mid-bloom to full-bloom stage of maturity, with as little as possible moisture from rain. If necessary, the crop may be wilted for a short period to lower the moisture content to the recommended level. Mouldy silage usually occurs as a result of ensiling a crop too dry. On the other hand, ensiling at a moisture level above the suggested limit may lead to the production of sour silage.

The Use of Carbohydrate Materials As Conditioners

Red clover can be ensiled under ideal conditions without the aid of conditioners such as carbohydrates. However, such materials do help to ensure and facilitate the process of silage making. An economical source of carbohydrate for the ensiling of red clover is blackstrap molasses which may be added at the rate of 40 to 60 pounds per ton of ensiled crop. Ground barley or corn applied at the rate of 80 to 100 pounds per ton may also be used for this purpose.

Figure 7.—The forage crop harvester will pick up, chop and load red clover crops for silage or dry hay.

The amount of conditioner added will depend on the legume content of the silage crop. When the mixture is predominantly red clover, especially when cut in the immature stage of growth, the upper limits of application are suggested, while the rate may be lowered as the percentage of grasses in the mixture is increased.

Type of Silo

Red clover may be ensiled in the vertical, tower type of silo or the horizontal silo. Where the tower silo is used, the crop may be harvested with a forage crop harvester and blower, or mower and green crop loader and then chopped with an ensilage cutter. In the case of the horizontal silo, the crop may be ensiled in either the long or in the chopped state. In either type of silo, the crop must be well distributed and packed to eliminate entrapped air. For horizontal silos this is best accomplished by means of a tractor or heavy truck. Considerably more labor is entailed in the filling of the silo and removal of the silage for feeding purposes when the crop is not chopped or cut. More care must be exercised in the spreading and packing of uncut than with chopped material.

Further information pertaining to the making of silage, and the equipment involved may be obtained from "Silage Production", Publication 525, and "Harvesting Machinery for Hay and Silage", Publication 885, Canada Department of Agriculture, Ottawa.

Amount of Silage to Feed

Red clover silage is used chiefly as feed for dairy and beef cattle. The amount of silage to feed the various classes of livestock differs with the animal and with the quality of the silage. A dairy cow may be fed 20 to 75 pounds of silage per day, depending on the size of the cow, the amount of milk produced and the amount and quality of additional hay fed. Beef cows may be fed 25 to 35 pounds, fattening 2-year-old steers 20 to 35 pounds, and breeding ewes 1 to $2\frac{1}{2}$ pounds per day.

RED CLOVER FOR PASTURE

Red clover, particularly when grown in mixtures with grasses and other legumes such as alsike and alfalfa, makes an excellent pasture. Like other legumes, when lush heavy growth is pastured, red clover may cause bloat in livestock. For this reason it is always well to seed grasses in mixtures with red clover if it is to be grazed.

In recent years, the practice of adding ladino clover to mixtures containing red clover is increasing in certain areas. This is particularly true in areas where ladino clover does well, as for example in the Eastern Townships of Quebec and in regions of British Columbia. The first growth, in the first crop year, is usually taken for hay or silage. The second crop or the aftermath is taken for hay or for pasture, or if the stand and seed set of red clover is good, the field is harvested for seed. In the second crop year the stand of red clover is usually light, and that is why the addition of ladino clover, if it is adapted, is valuable for the field may be used as pasture for a few years longer.

It has been found that red clover is a valuable constituent of most short-term hay-pasture mixtures used on the farms of Eastern Canada and British Columbia. This legume is short lived but provides abundant pasturage while the other more perennial species in the mixture are getting established.

SEED PRODUCTION

A large proportion of Canada's red clover seed is produced in Ontario and Alberta with lesser amounts in Quebec, British Columbia, Saskatchewan, and Manitoba. Production in the Maritime Provinces is very limited in most years. A portion of the British Columbia production and practically all the production in the Prairie Provinces is from the late or single-cut type of clover while the eastern production is almost wholly from the early or double-cut type.

Average production of seed in Canada for the 14-year period 1937-1950 was 5,749,214 pounds but yields varied widely from year to year. For example in 1942 only 1,598,000 pounds were produced while the 1948 production amounted to 16,086,000 pounds. Average yield per acre during the period 1939-1948 amounted to 109 pounds but actual yields have ranged from a few pounds to several hundred pounds per acre. Canadian domestic requirements of red clover seed are something in excess of 4,000,000 pounds annually. This means that in some years a considerable amount of seed is available for export.

While in Western Canada most of the red clover seed produced is from areas seeded for that purpose a great deal of the eastern production is from areas seeded out for hay production. This accounts for the wide variation in acreage harvested for seed from year to year. This also accounts to some extent for the relatively low yields which are obtained in some years because meadows have not been handled in such a manner as to give optimum yields.

Pollinating Insects

Red clover is for all practical purposes a self-sterile plant. Before fertilization can occur, and seed can be formed, pollen must be transferred between flowers of different plants The structure of the red clover flower does not permit pollen to move freely through the air and bring about seed set. Therefore pollen must be carried from one plant to another by insects. Most of the cross-pollination in red clover is done by bumblebees, other kinds of wild bees, and by honeybees. The amount of seed set will be governed largely by the presence or absence of useful pollinating insects even though other conditions may be favourable to good seed production.

Wild bees, particularly bumblebees, are very efficient pollinators. Generally, these bees are more plentiful in places where there are abundant natural nesting sites such as bush, brush-infested fence rows, and uncultivated ground. Honeybees, while not so efficient as the wild bees in bringing about cross pollination, are effective. However, when other nectar- and pollen-producing plants such as sweet clover, alsike and white clover are in bloom, the honeybees may not work red clover extensively. For this reason, in the case of the double-cut red clover it is rather important that the second growth be in full bloom at a time when other flowering plants are scarce and bees are present in large numbers.

As a rule red clover seed fields located in a vicinity where there are numerous colonies of honeybees will benefit greatly from the activities of the bees. Indeed the seed grower, if he does not keep bees, would be well advised to induce beekeepers to place colonies in his seed fields. At least one colony per acre should be provided and it is probable that a much higher concentration will be profitable.

Harmful Insects

Insects that affect the stand of red clover are discussed in another section of this bulletin. There are also a number of insects which cause damage to the seed crop. In some cases this damage can be so extensive that profitable seed yields will not be obtained. Injurious insects commonly found are the clover

seed chalcid, clover head weevil, clover seed weevil, clover midge, leafhoppers and grasshoppers. The presence of large numbers of insects such as these can be considered a serious menace to the seed crop. Fortunately it is possible to take measures to keep these insects under control. It has been found that the insecticide DDT will give useful overall control at the early bloom stage. Toxaphene has been found effective when applied at full bloom, particularly in the control of grasshoppers. There are a number of chemicals which are effective in the control of insects but there is reason to believe that their toxicity to pollinating insects is relatively high. On the basis of present information the following recommendations can be made for the use of insecticides on red clover meadows intended for seed production.

1. At the late bud stage apply 1·5 pounds actual DDT per acre as a spray. Use 20 or more gallons of water per acre. As an alternative apply 20 pounds of 10 per cent DDT dust per acre.

2. When further treatment is necessary because of reinfestation or a build-up in the grasshopper population, apply, at the full bloom stage, 1·5 pounds actual toxaphene per acre as a spray or apply 20 pounds of 10 per cent toxaphene dust per acre.

3. Do not feed the sprayed vegetation to livestock. Some authorities consider such vegetation is safe for feeding one month after the spray application.

Management of Red Clover Meadows for Seed Production

The single-cut or late type of clover is left undisturbed until seed is harvested. It will produce either a crop of hay or seed but not both in one season. The first growth of the double-cut red clover does not, as a rule, produce a good seed crop. The usual practice is to take the first crop for hay and take seed from the second crop. It has been found that in most seasons the proper time to cut the first growth is when it is about 50 per cent in bloom. At this stage the growth will be most suitable for hay and the subsequent bloom on the second growth will come in at a time most favourable for cross-pollination by insects. It frequently happens that the second growth blooms more profusely when the first growth is removed at the mid-bloom stage and thus the potential seed yield is greater. Furthermore there is reason to believe that cutting at this stage will materially reduce the infestation of seed-damaging insects such as the chalcid fly and the clover midge.

The early removal of the first growth helps in the control of weeds. Many weeds about to set seed are removed with the hay crop. If cutting is delayed seeds will have ripened and fallen to the ground where they will germinate and grow up into the second crop. The control of weeds in the clover seed crop is important because seed, to be saleable, must be relatively free of weeds particularly those kinds classed as noxious in the Seeds Act. Chemical control is not feasible so that cultural control, before the land is seeded out, is necessary if reasonably clean seed is to be obtained. Hand roguing of primary noxious weeds such as cockle and catchfly may frequently be worth while. The presence of those weeds and other weeds of a similar type in clover seed usually results in seed that is unsuitable for sale. Many weeds can be removed by modern cleaning machinery. However, when they are approximately the same size and weight as clover seed they are very difficult to remove by mechanical means.

When the first blooms have turned brown they should be examined to determine if seed has been set. At this time the heads should feel firm and full and when pulled apart green seeds should be found forming at the base of the flowers. If the heads feel soft and empty and green seeds are not found in abundance the crop should be cut for hay. A good heavy bloom is essential for seed production. On the other hand heavy, rank and lodged growth, or grassy and weedy growth, cannot be expected to give worth while seed crops.

Figure 8.—Threshing red clover by pick-up combine. The field was swathed several days previously. This method is the most labour-saving but is dependent upon good weather.

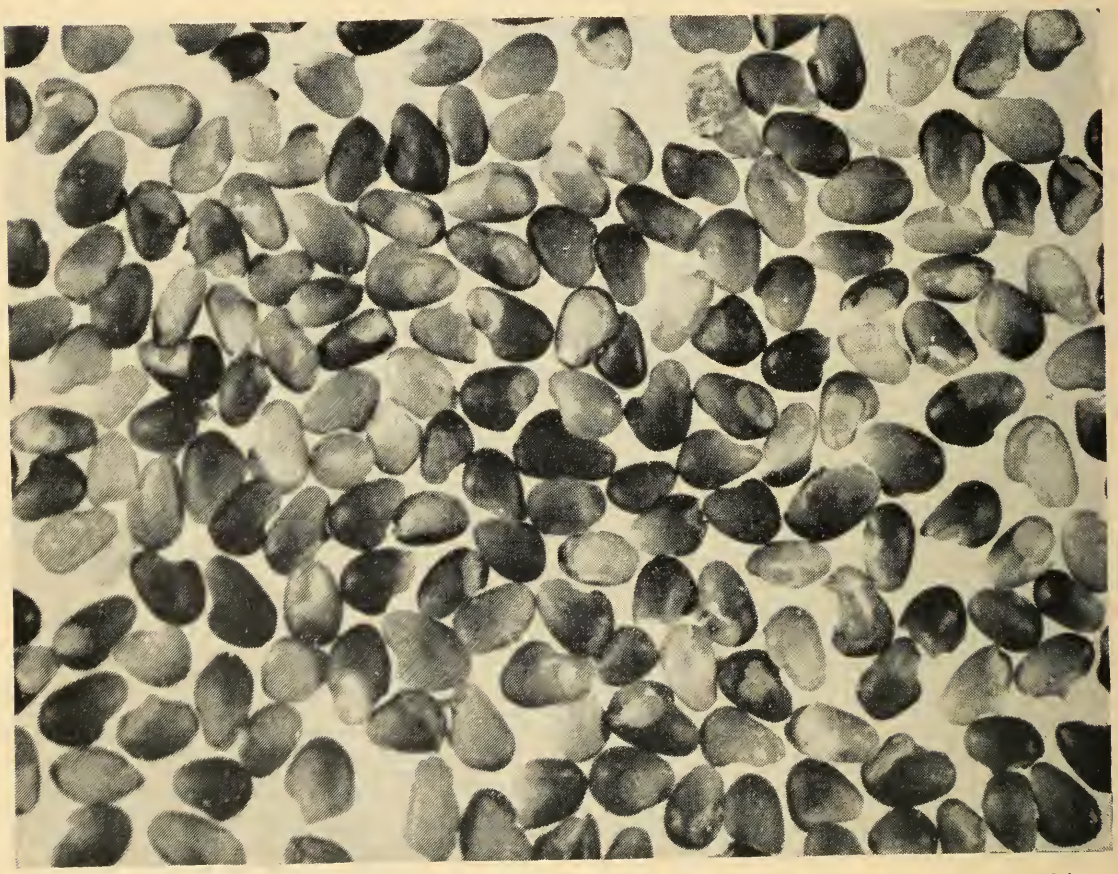

Figure 9.—Sample of red clover seed which has been badly damaged in the threshing operations. The high percentage of chipped and cracked seed is due to a poorly adjusted thresher. Such seed is greatly lowered in viability.

Harvesting

The clover seed crop may be considered ready for harvesting when most of the heads have turned brown or black. As with most other crops favourable harvesting weather is necessary. If cutting is to be done with a mower it should be done in the morning while the plants are still damp.

There are several methods by which seed is harvested. In the past the practice has been to cut with a mower equipped with a windrowing or bunching attachment. The crop is allowed to cure in the field, being disturbed only to the extent necessary to obtain drying. When dry the material is put through a clover huller or a grain thresher equipped with a clover attachment. This method while slow, permits the rethreshing of straw if necessary.

A common practice at present is to thresh the clover out of the windrow with a combine equipped with a pick-up attachment. This is a sound method which is suitable to a wide range of conditions but it precludes rethreshing of straw. It does save labour and the minimum amount of seed is lost in handling.

Continuing wet weather after the crop has been windrowed is a hazard when the above methods of harvesting are used. If the material stays in a wet soggy condition for any considerable time the seed is likely to germinate. Then again, repeated moving of the crop to enable it to dry results in considerable loss of seed by shattering. It is well to avoid unnecessary delay in threshing the windrowed crop.

Straight combining is very successful in some cases. To be efficient the combine must work in clover which is so dead ripe that the upper portions of the stems are brown, dry and brittle. Where an excessive amount of green material must pass through the combine, a good threshing job will not be obtained. The condition of the crop should therefore be considered before straight combining is decided upon.

Seed Drying and Cleaning

Seed obtained from combining or threshing is usually hard and low enough in moisture so that further drying is not necessary. Should the seed be damp however, it must be spread out and dried to avoid spoilage.

As a rule a good cleaning machine is necessary in order to remove weed seeds from red clover. It is therefore advisable to have the work done in a plant that is properly equipped. The ordinary fanning mill, with the proper screens, will be found useful for removing bulky material such as hulls and leaves from the seed, but cannot be depended upon to do a thorough cleaning job.

Home Grown Versus Imported Seed

Red clover seed production in Canada averages well above the annual domestic requirement of approximately 4,000,000 pounds. In some years, however, it is necessary to import large quantities and frequently this seed comes from European sources.

For a number of years the Forage Plants Division, Central Experimental Farm has tested numerous imported lots of seed with respect to winter-hardiness and general adaptability. It was largely on the basis of these tests that the seed staining regulations of the Department of Agriculture were put into effect.

Results of tests have shown that clover stands from imported lots of seed may range from fair to a complete loss depending on the source of seed, the severity of the winter and the abundance of disease and insects. In one 5-year period of the test the average percentage of winter killing was as follows: Northern United States 20·8, Northern Europe 21·3, Great Britain 36·5, Southern Europe 55·5. Under the same conditions Canadian red clover winter-killed 12·8 per cent.

Figure 10.—A typical red clover plant showing numerous branching, leafy stems above ground, and a number of primary roots with fibrous roots extending from these and from the base of the crown.

From this summary it is seen that Canadian seed produces a more hardy crop than seed from any other source. Next to Canadian grown seed, that from the Northern United States is to be preferred. The next best source is that from Northern European countries, especially Sweden, Finland, Poland, Russia, northern Germany and Great Britain. The least hardy red clover came from such countries as Australia, Egypt, Sicily, Italy, France, New Zealand and Chile.

It should be pointed out that even from Northern European countries, certain lots proved to be much less hardy than others but on the average Northern European countries gave much hardier seed than Mediterranean countries. A few lots of seed from France proved to be quite hardy but these probably came from northern parts.

Growing tests have shown that crops from imported seed lots are not so resistant as Canadian strains to the diseases and insects commonly found in this country. Some lots are badly attacked by sclerotinia root-rot disease and mildew and non-hairy types are damaged by leafhopper. The Seeds Act of Canada provides for the identification of source of origin of red clover seed sold in Canada. Importations from Great Britain are stained one per cent black, the United States one per cent methyl violet; New Zealand, Europe and Asia, except Italy and Turkestan, one per cent green; and any other country or region ten per cent red. Canadian grown seed is exempt from staining.

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